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Validation of a scoring system to predict difficult laparoscopic cholecystectomy

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ABSTRACT

Introduction: Laparoscopic cholecystectomy (LC) is one of the most common laparoscopic procedures being performed by general surgeons all over the world. Preoperative prediction of the risk of conversion or difficulty of operation is an important aspect of planning laparoscopic surgery. The purpose of our prospective study was to analyze various risk factors and to predict difficulty and degree of difficulty preoperatively by the use of a scoring system.

Materials: This prospective study was conducted in the department of surgery, Lady Hardinge Medical College and associated Dr Ram Manohar Lohia Hospital, Delhi, India. The parameters considered in the preoperative scoring method were old age, male sex, history of hospitalization, obesity, previous abdominal surgery scar, palpable gall bladder, wall thickness of gall bladder, pericholecystic collection and impacted stone. A total of 210 patients were included in the study.

Results: We found that history of hospitalization, palpable gall bladder, impacted stone and gall bladder wall thickness were statistically significant factors for prediction of difficult laparoscopic cholecystectomy. Sensitivity and specificity of this preoperative scoring method were found to be 95.74% and 73.68% respectively. Positive predictive values of this scoring method were 90% and 88% for easy and difficult cases respectively. Area under ROC curve was 0.86. Conversion rate from laparoscopic to open cholecystectomy was found to be 4.28%.

Conclusion: With the help of accurate prediction, high risk patient may be informed before hand regarding the probability of conversion and hence they may have a chance to make arrangements accordingly. On the other hand, surgeons also may have to schedule the time and team for the operation appropriately. Surgeons can also be aware about the possible complications that may arise in high risk patients.

1. Introduction

Laparoscopic cholecystectomy (LC) has become the procedure of choice for management of symptomatic gall stone disease.[1] It has been observed that surgeons encountered difficulty while LC when there were dense adhesions at calot's triangle, fibrotic and contracted gallbladder, acutely inflamed or gangrenous gall bladder and cholecystoenteric fistula etc.[2] There are many risk factors which make laparoscopic surgery difficult like old age, male sex, attacks of acute cholecystitis with fever and leucocytosis, obesity, previous abdominal surgery, clinical signs of acute cholecystitis, and certain ultrasonographic findings i.e. thickened gall bladder wall, distended gall bladder, pericholecystic fluid collection, impacted stone etc.[3]

Several studies had been carried out to assess the risk of conversion preoperatively. In a study conducted by Kama et al.,[4] six parameters namely male sex, upper abdominal tenderness at the time of surgery, previous upper abdominal surgery, sonographically ascertained thick gallbladder wall, age >60 years and preoperative diagnosis of acute cholecystitis were found to have significant effect on risk of conversion on multivariate analysis. According to another similar study by Lee et al.,[5] the risk factors for conversion included age >65 yrs, male sex, patients with previous upper abdominal surgery and a documented history of acute cholecystitis.

Preoperative prediction of the risk of conversion or difficulty of operation is an important aspect of planning laparoscopic surgery.

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With the help of accurate prediction, high risk patients may be informed before hand and they may have a chance to make arrangements. Surgeons too may get an indication so that they may schedule the time and team for the operation appropriately. Patients predicted to have a high risk should be scheduled for longer hospitalization and more intensive post-operative care. This may also help the hospital administration to plan and predict admissions and bed vacancy more efficiently.

Different scoring methodologies have been suggested from time to time using different criteria, further adding to the controversy. The following study was planned keeping in mind this basic knowledge of the uncertainties encountered on the operating table due to certain 'difficult' situations that arise during laparoscopic cholecystectomy. Our aim was to ascertain the validity of the scoring system devised by Randhawa et al.[6] in our hospital scenario.

2. Materials and methods

This study was conducted in a single unit, department of general surgery, Lady Hardinge Medical College & associated Dr. R.M.L. Hospital. A total 210 patients were included in the study after prior informed consent. This study was commenced after obtaining approval from the ethical committee of the institution.

Study design	Non randomized prospective study.
Study period	This study was conducted from November 2010 to October 2012.
Inclusion criteria	Patients with symptomatic gall stone disease.
Exclusion criteria	Patients unfit for anesthesia. Patients admitted with current attack of acute cholecystitis. Lap to open conversion due to equipment failure.

A preoperative score was given to every patient on the basis of history, clinical examination and sonological findings (Table 1). All the surgeries were performed by author 1 and author 3; both surgeons were having more than 12 years of experience in the field of laparoscopic surgery. Surgery was done using CO2 pneumoperitoneum with 10 mmHg pressure and using standard two 5 mm and two 10 mm ports. Time was noted from 1st portsite insertion till last port closure. All intra operative events like duration of surgery, bile/stone spillage, injury to duct/artery were recorded and surgery was labeled as easy/difficult/very difficult based on these findings (Table 2).

Table 1
Scoring factors used for grading the patient parameters.

		Score	Max score
History			
Age	≤50 yr	0	1
	>50 yr	1	
Sex	Male	1	1
	Female	0	
History of hospitalization for acute cholecystitis	Yes	4	4
	No	0	
Clinical parameters			
BMI	<25	0	2
	25–27.5	1	
	>27.5	2	
Abdominal scar	No	0	2
	Infraumblical	1	
	Supraumblical	2	
Palpable gallbladder	Yes	1	1
	No	0	
Sonography			
Wall thickness	Thin <4 mm	0	2
	Thick ≥4 mm	2	
Pericholecystic collection	No	0	1
	Yes	1	
Impacted stone	No	0	1
	Yes	1	

Score 0–5 easy, 6–10 difficult, 11–15 very difficult.

Table 2
Intra operative assessment.

Parameters	Score	Grading
Time taken <60 min & No bile spillage & No injury to duct	0–5	Easy
Time taken 60–120 min and/or Bile or stone spillage and/or Injury to duct	6–10	Difficult
Time taken >120 min or conversion	11–15	Very difficult

The scores were compared in each patient to come to a conclusion whether preoperative predictive score was a useful method or not. All statistical analyses were performed with the program Statistical Package for the Social Science 12.0 (SPSS Inc, Chicago, Illinois). A p value of ≤0.05 was accepted as statistically significant. Chi-square test/Fisher exact test was used to find the significant association of findings of preoperative score with intraoperative outcome. Area under ROC was used to find the diagnostic and predictive value of preoperative score for predicting the intraoperative outcome.

3. Results

A total of 210 patients were included in this study. Majority of the patients were females ($N = 180$) (85.71%). Following variables were analyzed (Table 3).

Mean intraoperative time was 45 ± 12.4 min (range 25–84 min). Cystic artery was injured in 3 cases but controlled with clips. Bile spillage was seen in 9 cases which were promptly managed with saline irrigation and suction. None of the cases required conversion because of cystic artery bleed or bile spillage. There were total 12 conversions in our study all because of dense adhesions at calot's triangle. Post operative hospital stay was 1.4 ± 0.4 days.

Multivariate analysis of intraoperative outcome with risk factors was carried out which depicted that only four variables (h/o hospitalization, palpable gallbladder, thick GB wall and impacted stone) were statistically significant in preoperative prediction of difficult laparoscopic cholecystectomy (Table 4).

At pre-operative score of 5, sensitivity and specificity of this scoring method were 95.74% and 73.68% respectively. Positive predictive values of this scoring method were 90% and 88% for easy and difficult cases respectively. None of the patient had score >10 (Table 5). Area under ROC curve was 0.86 (Fig. 1). Conversion rate from laparoscopic to open cholecystectomy was 4.28%.

Table 3
Distribution of parameters.

	Patient characteristic ($n = 210$)		Frequency
1	Age (years)	≤50	153
		>50	57
2	Sex	M	30
		F	180
3	History of hospitalization for acute cholecystitis	Yes	60
		No	150
4	BMI	<25	153
		25–27.5	15
		>27.5	42
5	Abdominal scar	Yes	12
		No	198
6	Palpable gall bladder	Yes	21
		No	189
7	Thick gall bladder wall	Yes	54
		No	156
8	Pericholecystic fluid collection	Yes	45
		No	165
9	Impacted stone	Yes	21
		No	189
10	Conversion		12

Table 4
Multivariate analysis of intraoperative outcome with risk factors (predictive association of risk factors with intraoperative outcome).

Risk factors	Level	Intraoperative outcome		*P* value	OR (range)
		Easy no. (%)	Difficult no. (%)		Multivariate
Age	≤50 years	111 (72.55)	33 (21.57)		
	>50 years	30 (52.63)	24 (42.11)	0.065	0.209 (0.04–1.1)
Sex	Female	120 (66.67)	48 (26.67)		
	Male	21 (70.00)	9 (30.00)	0.265	0.317 (0.04–2.49)
BMI	<25	114 (74.51)	30 (19.61)		
	25.0–27.5	6 (40.00)	6 (40.00)	0.454	
	>27.5	21 (50.00)	21 (50.00)	0.454	5.09 (0.234–111.2)
Scar	No	138 (69.70)	48 (24.24)		
	Yes	3 (25.00)	9 (75.00)	0.473	0.30 (0.009–9.654)
History of hospitalization	No	123 (82.00)	27 (18.00)		
	Yes	18 (30.00)	30 (50.00)	0.031	0.173 (0.035–0.85)
Palpable gallbladder	No	138 (46.03)	39 (20.63)		
	Yes	3 (14.29)	18 (85.71)	0.05	0.069 (0.005–1.004)
Thick gallbladder wall	No	132 (84.62)	24 (15.38)		
	Yes	9 (16.67)	33 (61.11)	0.005	0.078 (0.013–0.465)
Pericholecystic collection	No	135 (81.82)	30 (18.18)		
	Yes	6 (13.33)	27 (60.00)	0.939	1.038 (0.041–26.54)
Impacted stone	No	138 (73.02)	39 (20.63)		
	Yes	3 (14.29)	18 (85.71)	0.05	0.069 (0.005–1.004)

4. Discussion

Laparoscopic cholecystectomy was first performed in animal model by Fillipi, Mall and Roosma in 1985.[7] Philip Mouret in 1987 was the first to remove the gall bladder successfully through an unmagnified mechanical rigid pipe without doing laparotomy.

Initially, the complication rate with LC was high but with technological advancement and increase in the expertise, it has now reached a remarkably low level at 2.0–6.0%.[8] Conversion rate of 7–35% has been reported in literature.[9] In our study laparoscopic cholecystectomy was performed in 210 patients and different predictive risk factors for difficult laparoscopic cholecystectomy were analyzed. Old age, male sex, history of hospitalization, obesity, previous abdominal surgery, palpable gall bladder, and ultrasonographic findings like gall bladder wall thickness, pericholecystic fluid collection, impacted stone were included as risk factors in this study.

Old age (age > 50 years) has been found to be a significant risk factor for difficult laparoscopic cholecystectomy in many studies.[5,10] Higher conversion rate had been reported in old age group patients. In our study it is not found as a significant factor ($p = 0.065$) probably because of long surgical experience.

Male sex makes surgery difficult as being reported in studies.[10–12] Conversion rate and significantly higher mortality has been reported in male sex.[13] In our study it has not been found as a significant factor ($p = 0.265$).

Patient, who require hospitalization for repeated attacks of acute cholecystitis, carry more chances of difficult laparoscopic cholecystectomy and conversion, probably due to dense adhesions at calot's triangle and gall bladder fossa.[13,14] In our study also, it was found to be a significant factor for prediction of difficult laparoscopic cholecystectomy ($p = 0.031$). These cases required more time for dissection of calot's triangle and dissection of gall bladder from liver bed (>60 min).

Table 5
Correlation of pre-operative score and the outcome.

Pre-op score	Easy	Difficult	Very diff	Total
0–5	135 (64.28)	15 (7.14)		150
6–10	6 (2.85)	42 (20)	12 (5.71)	60
11–15	–	–	–	–
Total	141 (67.14)	57 (27.14)	12 (5.71)	210

Obesity has been considered as another risk factor for difficult laparoscopic cholecystectomy as observed by Rosen et al.[15] However certain studies claim that there was no difference in operative time, time to start general diet, length of hospitalization or complications[16] in obese subjects. In our study BMI >25 did not significantly affect the outcome ($p = 0.454$) and number of easy and difficult cases were almost equal in both groups of patients (BMI 25–27.5 and >27.5).

After previous upper or lower abdominal surgery there may be adhesions present between viscera or omentum and abdominal wall. There may be chances of injury to these structures during insertion of first port and risk of conversion was reported to be higher.[10,11] In our study only 12 patients had infra-umbilical scar and none of them had supra-umbilical scar. It was not found to be a

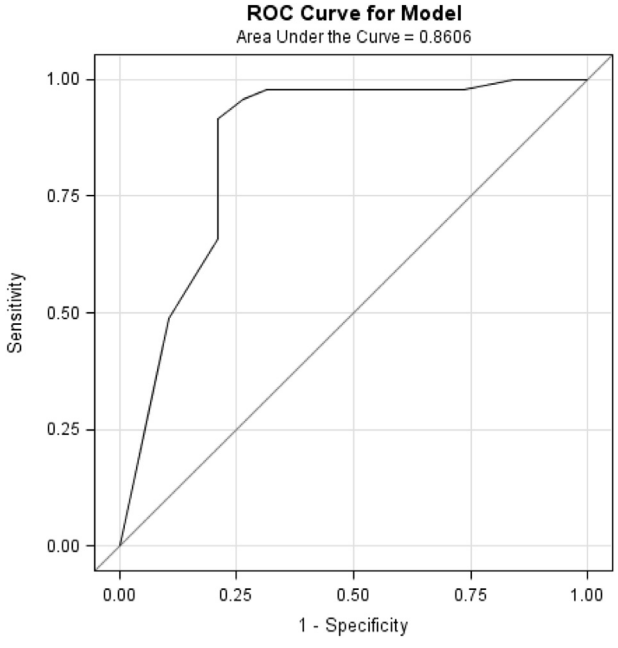

Fig. 1. ROC curve and its area under curve for prediction of intraoperative outcome based on preoperative scores.

significant confounding factor for difficult LC ($p = 0.473$) probably due to small sample size.

Palpable gall bladder is a clinical finding seen in patients with distended gall bladder due to mucocele or empyema etc. In distended gall bladder it is difficult to catch hold of the fundus of GB and hence aspiration of the contents of GB is often required. It is cumbersome, time consuming and also there is chance of spillage of contents into the peritoneal cavity. There is only one study by Randhawa et al. which has correlated palpable gallbladder with intraoperative difficulty with a significant association. In our study 21 out of 210 patients had palpable gall bladder. The outcome of our study was dependent on this variable ($p = 0.0037$) and it has also been found to be a significant factor ($p = 0.05$) in multivariate analysis.

Thickened gall bladder wall is an ultrasonographic finding of acute cholecystitis and it was a significant factor in previous studies.[11,17] Majeski James in 1990, showed that a preoperative gallbladder ultrasound evaluation for symptomatic cholecystitis, which documents a thick gallbladder wall (=3 mm) with calculi, is a clinical warning for the laparoscopic surgeon of the potential for a difficult laparoscopic cholecystectomy procedure which may require conversion to an open cholecystectomy procedure.[14] But Carmody E et al. concluded that detailed preoperative ultrasound evaluation of the gallbladder in patients destined for laparoscopic cholecystectomy is of little value in screening for difficult or unsuitable cases. They concluded that there were no ultrasound features that can differentiate between the unsuccessful, difficult, or uneventful laparoscopic cholecystectomy.[18] In this study thickened gallbladder wall was present in 54 patients and outcome was found to be dependent on this variable by chi-square test ($p = 0.001$), and logistic regression analysis also ascertained the significance of this factor for prediction ($p = 0.005$).

Pericholecystic fluid is an ultrasonographic finding of acute cholecystitis. This was not found to be a significant factor in our study ($p = 0.939$). Our findings are in accordance with the observations of Randhawa et al. On the other hand, palpable gall bladder has been found as a significant factor in our study ($p = 0.05$). Our study congrues with Randhawa et al. who also reported that presence of palpable gallbladder has a significant bearing on the difficulty index.

A scoring system was used in our study for prediction of difficult laparoscopic cholecystectomy. Sensitivity and specificity of the scoring system at score 5 for prediction of easy or difficult laparoscopic cholecystectomy are 95.74% and 73.68% respectively. Area under ROC curve is 0.86. Prediction comes true in 90% for easy and 88% for difficult. Previous study on this scoring method had sensitivity and specificity of 75% and 90.24% respectively with positive predictive values for easy and difficult as 88.8% and 92.2%, and area under ROC curve as 0.82.[6] Hence, in our study this scoring system was found to be more sensitive than previous study. However, positive predictive value for difficult cases was less as compared to the findings published by Randhawa et al.

Conversion rate reported in literature was between 7 and 35%.[9] In our study it is 4.28%. Undoubtedly experience of surgeon is an important factor that should be considered in for conversion, as it is low in cases done by experienced surgeons. In our study, all the surgeries were performed by most experienced surgeons (authors 1 and 3) in the team. Conversion because of cystic artery bleeding has been reported as a cause of conversion by Cuschieri et al.[19] In our study injury to artery occurred in only three cases but they were not converted and bleeding was stopped with clip application. Spillage of stones as a cause of conversion had been observed by Frazee R.C. et al.[20] But in our study none of the cases were converted due to this reason.

Bile spillage was present in 9 cases in our study, intra-operative time was ≤60 min, but these cases have been categorized as difficult due to bile spillage. None of these cases were converted and all were managed by irrigation and suction. In our study 12 cases out of 210 were converted, and the reason for conversion was dense adhesions between gall bladder and surrounding tissue like omentum, duodenum or colon leading to dense calot's triangle.

5. Conclusions

We may conclude that the scoring system evaluated in our study is a sturdy, reliable and useful benchmark to predict difficult cases. However, the small sample size may be an impediment in attaining complete statistical validity. We propose large scale, multicentric studies to validate the scoring methodology and establish its efficacy.

Ethical approval

Ethical committee of the Institution.

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Author contribution

Dr Nikhil Gupta: Manuscript writing, data collection, design.
Dr Gyan Ranjan: Data collection, writing.
Dr Poras Chaudhary: Design, analysis.
Dr Arun kapur: Analysis.
Dr M P Arora: Design, analysis, writing.
Dr Binita Goswami: Writing, analysis.
Dr Rajeev Kumar: Writing, analysis
Dr Tirlok Chand: Design, data collection.

Conflict of interest

None.

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